Chapter 3

Petrozuata - the Relationship between High IRR and Political Risk

Summary of Conceptual Valuation Errors Made in the Petrozuata Case

Many of the case studies discussed in the remaining chapters of this part of the book use articles published by the Harvard Business School ("HBS") on case histories of particular companies. These case studies can be of interest in studying conceptual valuation mistakes because quite a few people may be familiar with the stories from taking courses in business school. But hopefully, the perspective in the analysis of the cases presented in the next chapters is very different than the business school discussions where management and financial institutions are generally applauded. When you attend business school you are supposed to look-up to brilliant managers who have previously earned a degree from your institution and then write-up a case study about their company. In analyzing cases here, the idea is different. The objective involves evaluating whether valuation problems are due to unpredictable events or result from analytical mistakes that occur regularly. The idea is to investigate valuation mistakes according to the French saying: Le défaut apparaît-il régulièrement ou de manière sporadique ? Est-il possible de le reproduire ?

Some of the remaining cases are not very recent and one may complain that they do not reflect the latest trends in innovative financial products and market conditions. But by using cases where valuation analysis has previously been made and the valuation result is known -- large stock price decline, a bankruptcy, debt restructuring or a nationalization -- a review of why the case failed can be evaluated. With hindsight, the implicit or explicit economic assumptions and theories of valuation that were applied when the investment was made can be evaluated. The case in this chapter involves a famous oil project developed in Venezuela. The company making the investment for this first case was named Petrozuata. The case has been used frequently in business schools as an example of successful application of project finance. In the world of finance, the project

was legendary for a number of reasons including: (1) it was the largest project financing and project bond offering in Latin America to date; (2) it was able to obtain project credit ratings above sovereign credit ratings of Venezuela despite oil price risk; (3) at the time of financing, it had the highest credit rating for a project in Latin America; (4) debt on the project had no political risk insurance despite being located in Venezuela; and, (5) bank loans for the project had the longest maturity to date in Latin America.

The discussion of Petrozuata is derived from various different sources that document the financing and the risk analysis of the project. The primary reference is a Harvard Case Study write-up that is also included in the book *Project Finance Case Studies*.[1] Additional sources include an article written by Professor Benjamin Esty titled *Petrozuata: A Case Study in the Effective Use of Project Finance*.[2] A third source that is particular to this case is an article titled *Petrozuata, Teaching Note*[3] which is available on the internet. This article that is referred to as the Teaching Guide provides an insight as to how business school interpret various issues that are supposed to guide discussion of the case and what kind of analysis is taught to students who are soon to enter the world of finance. Other sources include the arbitration cases concerning nationalization of the project and *Project Finance: Practical Case Studies*[4].

The HBS case study write-up and the associated articles focus on financing of the project and laud the fact that the project finance structure was a breakthrough. Each year various organizations give awards for the best project finance transactions. This is something akin to academy awards that are selected for films in Hollywood. Presumably, there are award dinners after which bankers like actors give irritating speeches congratulating themselves for innovative transactions. The Petrozuata project finance transaction not only won all of the awards, it was even called the "deal of the decade" and praised for the manner it was able to raise capital and achieve investment grade ratings. But this transaction that was supposed to be such a success was nationalized a few years after it began operation and is currently the subject of a bitter dispute about compensation between Conoco, the American company that made 50.1% of the equity investment in the project, and the country of Venezuela. The Petrozuata project was developed in the late 1990's, completed in 2002 and nationalized five years later in 2007.

[1] Case Studies in Project Finance,

[2] Footnote on date of article

[3] Authored by Mathew Millet in 1999.

[4] Project Finance: Practical Case Studies, Second Edition, VOLUME II, Resources and Infrastructure, Henry A. Davis, Euromoney Books, Nestor House, Playhouse Yard, London EC4V 5EX, United Kingdom, Copyright © 2003 Euromoney Institutional Investor PLC

This chapter addresses why such a highly praised investment ended up being subject to such problems for the Conoco. Instead of simply blaming political uncertainty and an irrational, out of control politician, Hugo Chavez, analytical issues associated with political risk are addressed. Some of the flaws in analysis that led to nationalization can be found by stepping back and asking general questions about who deserves economic rent from oil production and how to evaluate political risk. With the benefit of hindsight, valuation errors that were made in the Petrozuata case and arguably ultimately led to its disappointment for equity investors included:

- Not beginning the evaluation of an investment by analysis of the production cost and the cost structure of an investment relative to competing alternatives.
- Using measures of IRR to evaluate the economic profit on project financings and not considering what it really means to earn a high IRR over a long period of time.
- Not correctly measuring political risk and applying an extremely high equity risk premium to the cash flows and not explicitly measuring the probability of expropriation implicit in credit spreads.
- Assumptions that off-shore accounts and partnership structures can reduce or eliminate political risk.
- Applying Monte Carlo simulation does not answer anything about value, risk or debt structure.

Synopsis of the Petrozuata Case

The HBS case for Petrozuata begins by describing how financial management of the project had a big challenge in finding an optimal mix of financing from different sources. Political and economic problems are then discussed to point out how difficult and expensive the financing would have been had conventional debt issued by state been used. The national oil company of Venezuela named PDVSA, the second largest state-owned oil company in the world, is described in the write-up. However PDVSA had a very low junk-bond rating of single-B that was driven by the credit rating of risks associated with the country of Venezuela. In the early 1990's Venezuela embarked on a strategy to make investments of $65 billion in the upstream production industry called "the opening." A PDVSA executive quoted in the case explained that for the company, "the most limited resource … is money."

Petrozuata was the first of four strategic associations between PDVSA and foreign partners to develop heavy oil. In 1960, Venezuela was a founding member of OPEC and in 1975 it nationalized its oil production limiting private investment. The Petrozuata project and other partnerships that were formed to develop, transport, upgrade and market extra-heavy crude oil from different defined areas in the Orinoco Belt were allowed by legislating an exception to the 1975 law. The Orinoco Belt, located in Eastern Venezuela and north of the Orinoco River, had been largely untapped because of the oil's heavy, high sulfur characteristics, and the lack of infrastructure, markets and investment capital. Deposits in the belt are extra-heavy oil, which is a tar-like substance that acts as a dense liquid underground, but solidifies once brought to the surface. Private investment was permitted by the Venezuela congress in the Orinoco belt through joint venture partnerships with the private-sector partners that were exceptions to the 1975 law.

Petrozuata was the first of the four Orinoco Belt partnerships to be developed. Each of the projects received tax breaks to encourage the investment that were presumably negotiated by the foreign equity investors. Specifics of the tax breaks are outlined in the arbitration reports. A royalty rate of 16.33% was part of the 1943 hydrocarbons law in Venezuela and this royalty was temporarily reduced, for 9 years, to 1% for the Orinoco Belt projects. In addition, the income tax rate of 67.7% that was supposed to be applied to oil projects was reduced to the overall corporate tax rate 34%. Sponsors of the Petrozuata project were a subsidiary of PDVSA named Marven that owned 49.9% and Conoco who owned 51.1%. The oil concession was to last 35 years after which Conoco shares would be given to PDVSA. In the HBS case write-up, Conoco was lauded in the case as being "a leader in the world in both refining technology and project development." The case noted how Conoco had earned the Distinguished Achievement Award from the Offshore Technology Conference.

The project is described by various different sources as consisting of three parts: (1) 530 production wells that apply horizontal rather than vertical drilling; (2) a pipeline system that transports the oil to a port at San Jose; and (3) an upgrading facility to partially refine the heavy crude oil. The HBS case notes that the project has little exploration risk and is termed a development project. The general nature of the project can be seen in Figure 3.1 that displays the sources and uses of funds. A sources and uses analysis is an effective way to paint a picture of the project during from where expenditures are made. The uses and sources statement demonstrates that more than half of the expenditures (60%) are for the upgrader. The estimated oil reserves from the allocated 300 square km area of the Zuata area of the Orinoco Belt of 21.5 billion cover the 120,000 barrel per day capacity of the upgrader by a very wide margin. You can divide 21.5 billion by 35 years and then by 365.25 days to derive potential production from the area. Then you can divide that number by the capacity of the upgrader to derive a margin of

14 times. This simple calculation demonstrates that risks of not producing enough reserves to cover the production of the upgrader was not a serious issue.

	1996	1997	1998	1999	2000	Total
USES						
Capital Expenditures						
Crude Oil Production	$11,995	$191,849	$151,141	$77,092	$16,702	$448,780
Crude Oil Pipeline	655	170,512	45,121	0	0	216,288
Upgrader & Loading Facility[a]	14,345	243,305	510,987	230,306	67,912	1,066,854
Upstream Contingency	0	0	0	0	37,925	37,925
Total Capex	**$26,994**	**$605,666**	**$707,249**	**$307,399**	**$122,539**	**$1,769,847**
Other Costs						
Deferred Development Costs and Operating Expenditures	$52,040	$23,328	$71,724	$0	$0	$147,093
Initial Cash Balance	0	0	10,000	0	0	10,000
Financing Costs	0	61,134	86,816	94,955	111,556	354,461
Legal & Advisory Fees	0	15,000	0	0	0	15,000
Debt Service Reserve	0	0	0	0	80,865	80,865
Excess Cash Balance	0	47,213	0	0	195	47,408
Total Uses	**$79,035**	**$752,341**	**$875,789**	**$402,353**	**$315,155**	**$2,424,673**
SOURCES						
Total Project Debt	**$0**	**$1,000,000**	**$24,299**	**$242,981**	**$182,720**	**$1,450,000**
Shareholder Funds						
Initial Paid in Capital	$79,035	$0	$0	$0	$0	$79,035
Additional Paid-in Capital	0	1,986	550,148	-1,576	-185,047	365,511
Operating Cash Flow[b]	0	47,213	4,484	160,948	317,481	530,126
Total Shareholder Funds	**$79,035**	**$49,199**	**$554,632**	**$159,373**	**$132,434**	**$974,673**
Total Sources	**$79,035**	**$1,049,199**	**$578,931**	**$402,353**	**$315,155**	**$2,424,673**

Figure 3.1 – Petrozuata Uses and Sources of Funds Pre-Commercial Operation

After explaining the project, the HBS case write-up provides a complete description of the structuring of the Petrozuata project including independent engineering analysis, EPC contracts, construction guarantees, letters or credit, completion tests, the off-take contract and other features. The teaching note explains that Petrozuata was an “extremely well crafted deal” and how project finance can “create value … with skilled execution”. Presumably this means the project was able to effectively manage risk by using contracts to allocate the risk to different parties. In the teaching note, project finance is defined first as “asset based financial engineering” and then as “a financing of a particular economic unit in which lender is satisfied to look initially to the cash flow of earnings of that economic unit as the sources of funds from which a loan will be repaid and to the assets of the economic unit as collateral for the loan.”[5] This definition of project finance demonstrates nothing other than how finance language makes a relatively simple concept complicated.

An alternative definition of project finance can be derived from thinking about an amorous relationship that has different phases and risks. The relationship

[5] Nevitt, Peter, K.,1983, Project Financing, 4th Revised Edition (London: Euromoney Publication, 1983), p.3

project begins with a dating phase which is analogous to the development period in project finance. Here the risks of project failure are high but the expenditures are not great. No third parties are generally involved in paying for dinner dates or permitting cost. If the development proceeds, financial close is achieved where a commitment fee is made to the bank. In the relationship analogy, the engagement is agreed to after a proposal and a commitment fee is made by paying for an engagement ring. After large expenditures for construction (or a wedding ceremony and the first house), the commercial operation date occurs. After this date, risks change a lot. Now the operation of the project must generate enough money to pay back debts as a family must pay off mortgages and obligations related to children. After a few years of operation, the risks of the project may further decrease as there is some history demonstrating the project (marriage) can really work. Eventually, the project just ends (one of the people dies). Figure 3.2 illustrates phases of the Petrozuata project along with the actual and projected oil price. The graphs in Figure 3.2 demonstrates actual oil prices were dramatically above oil prices used by investors and lenders in assessing the investment.

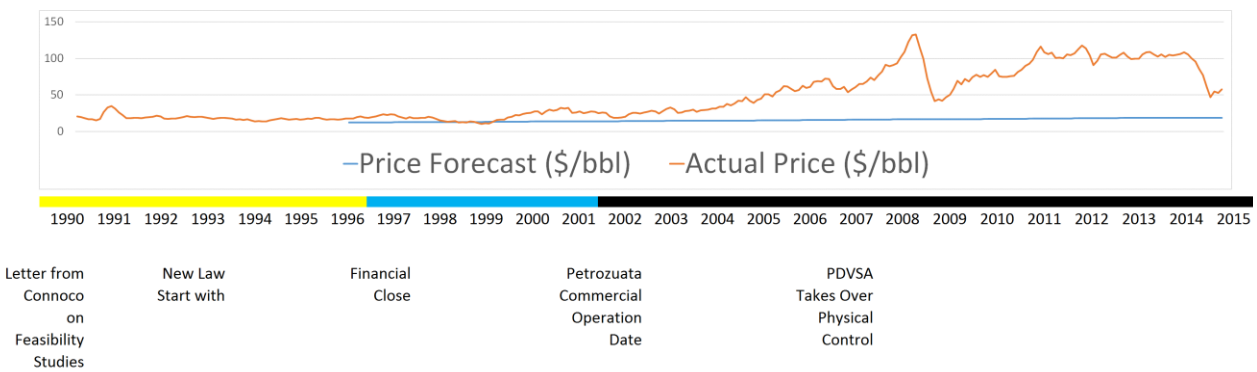


Figure 3.2 – Petrozuata Time Line with Project Finance Phases

To see why Petrozuata was touted as the deal of the decade, you can look at the sources side of the uses and sources statement presented in Figure 3.1 (the statement measures inflows and outflows from financial close to commercial operation). A large chunk of financing from debt, $1 billion of bonds, occurred just after financial close of the project the project in 1997. Development costs were financed with equity and the sponsors, Conoco and PDVSA put $550 million into the project a year later. Including the subsequent financing from banks, the percentage of debt contributed relative to the debt and equity contributed was 76%. (There are other ways to compute this number by including the operating cash flow as equity, but it can be argued that the initial operating cash flow came about because of the debt and equity funding and that the equity percentage should only include true contributions of cash.) Much of the HBS case write-up describes

issues debt financing of the project including interest rates, the way the debt was to be repaid, interest rates and covenants.

One of the most remarkable parts of the debt financing were the low credit spreads that were achieved on the project. Credit spreads compensate lenders for taking risk and are measured in basis points (100 basis points is 100%). The credit spreads above base interest rates for the bonds and the bank debt were all below 2.3%. This is far below the credit spreads that could have been achieved if PDVSA would have issued its own bonds. The spreads on the bonds were less than the spreads on the bank debt because the bonds were able to achieve an investment grade credit rating. This rating was granted even though no political risk insurance was added to the cost of the bonds or the bank debt. The spreads for bonds and maturities were:

$300 million 12-year maturity at 130 over treasuries (7.63%)
$625 million 20-year maturity at 145 over treasuries (8.22%)
$75 million 25-year bullet bonds at 160 over treasuries (8.73%)

For the bank debt, the maturities were shorter and the interest costs were somewhat higher:

$200 million 14-year maturity at 220 basis points
$250 million 12-year maturity at 208 basis points.

If the sources and uses statement paints a picture of the project during the construction phase of the project, a cash flow and debt service diagram can be made for the project after the construction period. This picture that shows the cash available for debt service and the debt service is presented in Figure 3.3. Risks for the lenders can be seen by looking at the buffer between the cash flow and the debt service as well as the buffer at the end of the debt service period. Even at a low oil price that does not exceed $18.64 in nominal terms, the project experienced a minimum debt service coverage of 2.08. When measuring the present value of the cash flows relative to the debt service called the PLCR, the coverage was 3.48. The DSCR, LLCR and the PLCR can be translated into the break even oil price through computing the percent decrease that can be accepted (these ratios and computation of the break even points are discussed in the last section of this chapter).

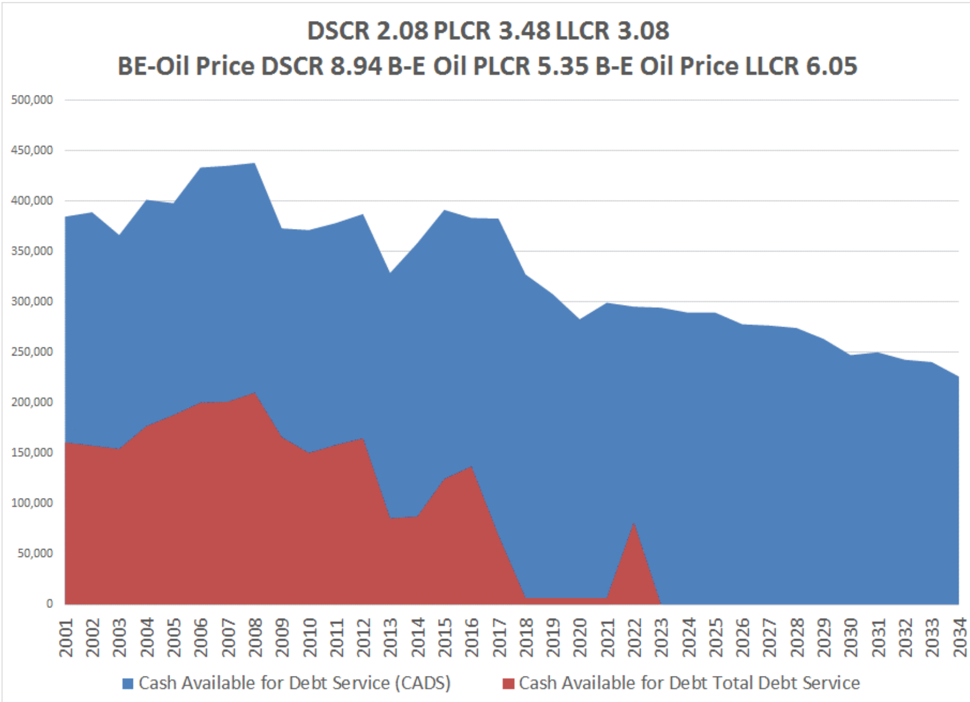


Figure 3.3 – Petrozuata Cash Flow and Debt Service Buffers Using Oil Price Estimates

With the debt structure defined, various risks can be evaluated. Ben Esty's article *Petrozuata: A Case Study in the Effective Use of Project Finance* works through different risks in the project for alternative phases. A risk matrix is presented that demonstrates the only risks taken on by creditors was the possibility of the oil price falling below $8 for long periods of time and political risk, The article by Esty and the Teaching Note discuss all sorts of ways that political risk was mitigated including: (1) the need for Conoco's expertise; (2) the inability to attract more foreign investment after a nationalization; (3) retaliatory actions by foreign governments; (4) the fact that PDVSA, a government owned entity, is a partner in the project; (5) the ability of Conoco to refine the oil that comes out of the upgrader (called syncrude); (6) use of off-shore accounts in the cash flow waterfall; and (7) the use of debt leverage. These mitigants are typical of the writing in credit memos where bankers justify to themselves that acceptance of risks is reasonable. The discussion also is used to explain why creeping expropriation through increased taxes would not occur.

To be sure, there are valuable project finance structuring lessons in the case. Without project finance, project may not have been built or would not be feasible because of a high cost of capital. With project finance, risks were put into a closed fence and were able to be quantified without worrying about a host of unknown issues associated with PDVSA that could suddenly appear. However, as

stated above problems with the project arose fairly quickly. The time line in Figure 3.4 demonstrates events that led up to the nationalization in 2007. Petrozuata's bonds were repaid, but compensation to equity holders remains a subject of bitter dispute.

Valuation Flaw 1: Begin by Understanding the Implications of the Cost Structure and Pre-tax Cash Flows

The ultimate issue in the oil industry when it comes to private investment is who gains the economic benefits – the difference between the oil price and the production cost -- for resource that is under the ground. In the U.S., people lucky enough to live above oil fields and private oil companies that explore and develop the reserves receive the economic benefits of the difference between prices and costs. By contrast, Saudi Arabia famously nationalized its industry in the 1970's, a little more than two decades after oil was discovered in 1949 largely by accident. In other countries such as Indonesia and Kasikstan, profits on oil exploration are carefully regulated through production sharing agreements. In analysis of risks and value, the first questions that should have been addressed before all of the project financing structuring analysis and cash flow waterfalls is how much economic rents economic rents were generated for foreign companies that would not be available to people in Venezuela. The Petrozuata project included a foreign investor without sharing or upside or downside risks associated with oil prices. Whether this structure makes sense or whether another structure such as hiring Conoco as a consultant should have been the first question in the case. It was not.

In all of the Petrozuata cases write-ups and other articles there is no mention of the cost of production for the project and there is no computation of the overall return on the project. Production cost of the project including a return on investment provides a basis to evaluate the economic rents accruing to investors and can be the first step in considering political risk as well as the project economics. The first valuation mistake in the case write-ups is therefore not beginning by asking basic questions involving whether a scenario with low production costs and high profits is logical and sustainable for a foreign investor. This is analogous to the point that for any investment, the starting point should be evaluation of EBITDA, capital expenditures, working capital changes and taxes. These operating cash flows form the basis for evaluating how the cash flow is later split-up. If the operating cash flows produce a rate of return below the interest rate for base case scenarios, the project should not proceed. More specifically, when the project IRR is below the all-in debt cost, the company is not generating

sufficient cash flow to cover its cost of capital. A more interesting question arises on the other side of the equation. When the project IRR is very high, questions need to be asked whether the project is too good to be true and what is so special about this project that allows it to.

To demonstrate the usefulness of measuring production costs, consider the issue of whether shale oil and gas production is viable over the long-term. Ignoring the environmental issues associated with shale gas, a fundamental question involves the real production costs of using fracking to produce oil and gas. Shale oil and gas often suggested as a big reason the U.S. was able to recover from the recession of 2008. You can look on the internet and find ranges in production cost for shale oil that vary between $40 and $100 per barrel. If the production cost of shale oil is above $100 per barrel, many of the investments may turn out to be uneconomic and the shale oil boom may be something akin to the housing bubble before the global financial crisis. On the other hand if the production cost is in the range of $40 per barrel as others suggest, then shale oil does deserve all of the hype. An estimate of production costs made by Goldman Sachs where projects are assumed to earn a return of 11% is displayed in Figure 3.4.

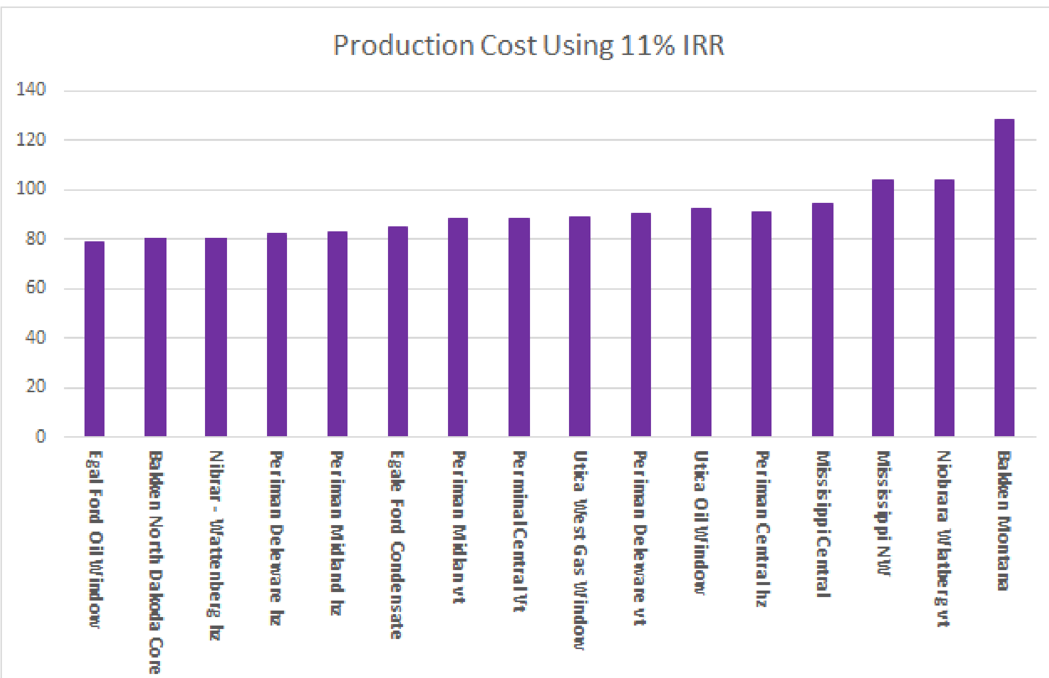


Figure 3.4 – Estimated Production Costs for Shale Oil (Goldman Sachs)

Computing production costs of shale oil challenging because of uncertainty associated with the amount of production that will be generated from capital expenditures made from drilling. The decline curve for share oil reserves is short, meaning that new wells must be continually be drilled resulting in what some have called the drilling treadmill. Further, the production generated from new wells could decline as the low hanging fruit is the first to be developed and subsequent projects are less productive. Evidence of high production cost is financial problems of some shale oil investments when the oil price was above $100 per barrel. For example, Shell oil took a $2.1 billion write-off of shale oil investments in Texas in 2013. At the time it made shale oil investments Shell expected to produce 250,000 barrels of oil per day.[6] But the company admitted "the production curve is less positive than we originally expected" and it is only producing 50,000 b/d from these properties. While there are many other examples of companies with financial problems during high oil price periods, investor presentations made by various companies suggest the cost of drilling is not very high, especially compared to deep water alternatives. The reports suggest high IRR's can be earned on drilling even when the oil price is low.

The production cost of Petrozuata can be computed from the capital costs of the upgrader, pipelines and the drilling costs for upstream facilities as well as the operation and maintenance costs and taxes. In computing the capital cost component of production costs, amounts must be levelized and converted to real currency. Cost of money, production, taxes and inflation complicate the calculation. The techniques for computing and evaluating production costs are described at length in Part 4 of this book. In addition, a video describing how to compute the costs is included on the associated website. As the mechanical calculations are documented in Part 4, details of the calculation are not repeated here. Compared to the shale oil and gas industry where the key question is the level of production, computing the cost of production for Petrozuata is a relatively straightforward process. Figure 3.5 presents the production costs using different overall costs of capital ranging between 8% and 12%.

[6] Financial Times, August 1, 2013 "Shell write down is bad news for US shale", Guy Chazanhttp //www.ft.com/cms/s/0/cf41cc36-fab2-11e2-87b9-00144feabdc0.html#ixzz3YM0hydc6

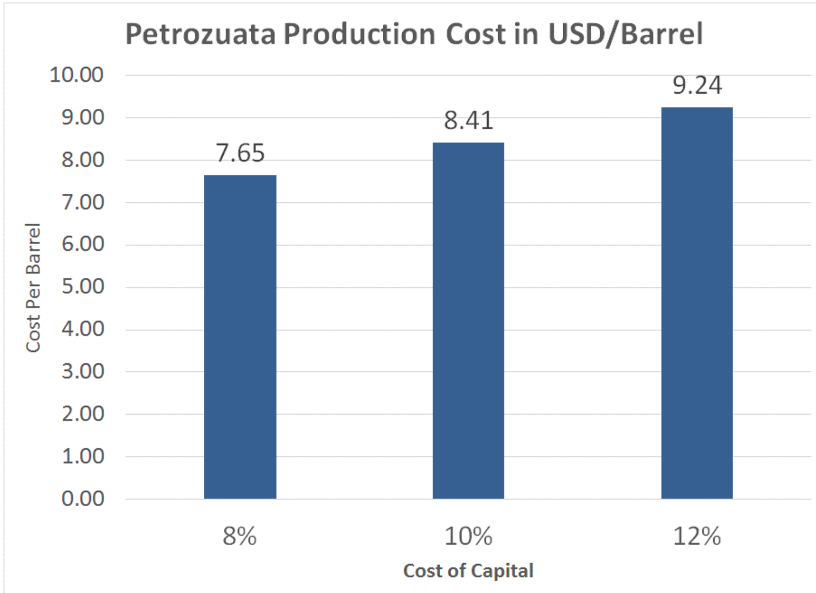


Figure 3.5 – Petrozuata Production Cost with Different Overall Cost of Capital

The fundamental issue in this case is just who gets the difference between an oil price of something like $100 per barrel and the production cost shown in Figure 3.5. One could imagine a stacked bar where the top or the bar is $100 and the space between the production cost and the production cost must go to somebody. In the Petrozuata case, using the $18 per barrel oil price, all of the money represented by the space between the oil price and the production cost goes to foreign investors. When the oil price increases above $18 per barrel, most goes to investors and some goes to the government in terms of royalty and income tax. With most of the money accruing to investors, it would be naïve to believe that ownership and sharing structure is sustainable in most countries.

In the case of Petrozuata, tax breaks were granted to the equity investors in the Orinico Belt projects meaning that less of the difference between the oil price and production cost accrues to the government than would occur in oil projects that did not receive special tax treatment. The tax breaks presumably were made because the investors maintained that the investment could not be made without the favorable treatment (nobody else had an incentive to reduce taxes). An odd argument for project finance was presented in the teaching note: "Petrozuata captures tax benefits that PDVAS cannot….[I]f PDVSA had financed the project internally, it would have been subject to a 67.7% tax rate and a 16.67% royalty rate." As PDVSA is part of the government of Venezuela, the taxes paid by PDVSA are not relevant in considering the production cost. The taxes paid by one arm of the government simply go to another arm. The only argument for maintaining the tax treatment was the government of Venezuela would be violating an earlier agreement.

Now that we know the oil price has been above $100 per barrel for long-periods of time, it is clear that the first question in the case should be, and should have been when the project was developed, is how will people who live in the country find it acceptable to give away the difference between the production cost and the oil price to a foreign investor. This potential scenario with higher oil prices suggests that the simple structure of allowing foreign firms without sharing some of the gains may have been a dangerous strategy. It is easy to laugh at Hugo Chavez and suggest that this is simply a crazy socialist, but the notion of who really should receive economic profits has little to do with Hugo Chavez. It would be present for a natural resources in any country. Figure 3.6 presents a time line that includes political events including the election of Hugo Chavez, the attempted coup, increases in the royalty rate, increases in the tax rate and the ultimate nationalization.

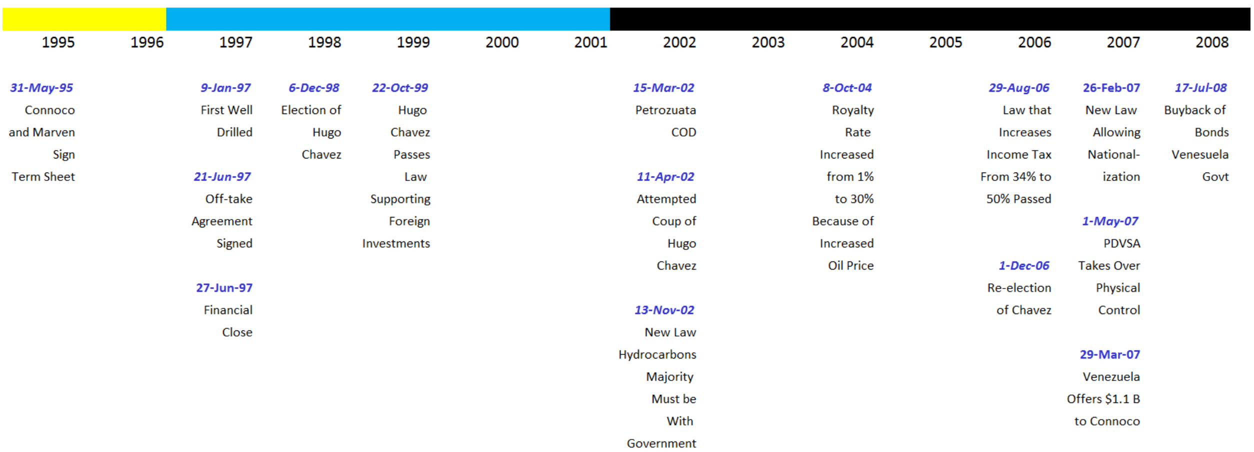


Figure 3.6 – Petrozuata Time Line with Political Events

Valuation Flaw 2: Interpreting Value of a Project Finance Investment with High IRR over Long Periods

The teaching note to the case commented that Petrozuata's IRR for the base case is 25.6% and implied that this was a reasonable number relative to the cost of capital. The equity IRR can computed by putting the equity outflows next to the inflows in the case write-up and then applying the IRR function in excel. The Teaching Guide later proceeds to discuss a more complex approach called a quasi-market valuation (QMV). (This is nothing more than computing the present value

of prospective cash flows but it has a fancy acronym.) Difficulties in interpreting high IRR's that are measured over long-periods is the valuation problem discussed here and in particular, just how much money do projects with high IRR's provide to equity holders. When IRR's are above double digits and cash flow is earned over long periods, the statistics quickly become all but meaningless. The cash to investors when the IRR is high becomes enormous simply because of the mathematics of compound interest and the IRR indicator does not show just how much is being earned. Alternatives to the IRR that measure how much is generated relative to other investments that could be made with the money that is injected into the project.

An alternative to computing the IRR that would should be immediately dismissed by any MBA student is computing the payback period. At the very low oil prices assumed in the case, the investment made in 1998 and that enters service in 2000 is fully paid back after 3 years of operation in 2002. For people with a sophisticated financial background, this payback analysis would be immediately dismissed because it does not account for cost of money or risk. But it may tell more about the profitability of the project than the IRR. If your money is paid back in a couple of years at a low oil price and the rest is upside, the investment is very profitable. You don't need much more fancy analysis.

Over the past couple of decades managers have become more and more enamored with the equity IRR. In a single statistic you can summarize the entire profitability of a project and compare returns across different projects. For a leveraged buyout that has a single cash outflow and a single cash outflow, the IRR is simply a measure of the compound growth rate on the investment and there is no ambiguity about the statistic. Conoco has asked for $30 billion from the country of Venezuela as compensation for its investment in the arbitration process. When this cash inflow is compared to half of the $500 million equity investment made in 1998 shown in the sources and uses of funds statement, the IRR calculation can be made on your I-phone. You divide $30 billion by $250 million and then raise the result to the number of years between 2015 and 1998 minus 1. This number that does not account for cash flow earned by Conoco from 1998 through 2007 results in a CAGR or IRR of 32.5%. It demonstrates just how much is generated from a high IRR. If the IRR were 10% and the investment were $250 million, the one-time cash flow at the end of the period would be $1.275 billion instead of $30 billion. The example demonstrates that numbers are dramatic and become so big that they are practically meaningless when IRR's are high. The mathematics of why high IRR's are not useful in measuring value are discussed in Chapter ___ of Part 3.

When the cash flows occur in intervening periods instead of all at the end of the project, interpretation of the IRR statistic becomes a lot more difficult. A

question that was raised by a lawyer a few years ago was what all this business about IRR is anyway. The question is not so easy to answer, especially when the IRR is high and there are continuing cash flows. With high cash flows generated soon after the investment is made, the IRR is high even if no future cash flow goes into the pocket of equity holders. In these cases the future cash flows seem to make no difference at all in the IRR calculation. For the Petrozuata data presented in the HBS case where nominal oil prices do not increase above $18.64 per barrel more cash flow accrues to the project at the end of the project than at the beginning of the project in the numbers presented in the HBS case. Even though out year cash flows are high, the IRR does not change with future cash flows. Figure 3.5 displays the IRR where cash flows after various dates are ignored and assumed not to be given to equity investors after various end dates. The graph shows the IRR has virtually no change after year 2009. However, nominal cash flows after 2009 are even more than the cash flows before 2009. In business school you can try to explain away why this is reasonable. The result does not make sense. Chapter ___ of Part 3 explains the mathematics of the IRR and why results like this that do not make sense occur. A video on the associated website www.edbodmer.com demonstrates how to create this analysis from data presented in the HBS case.

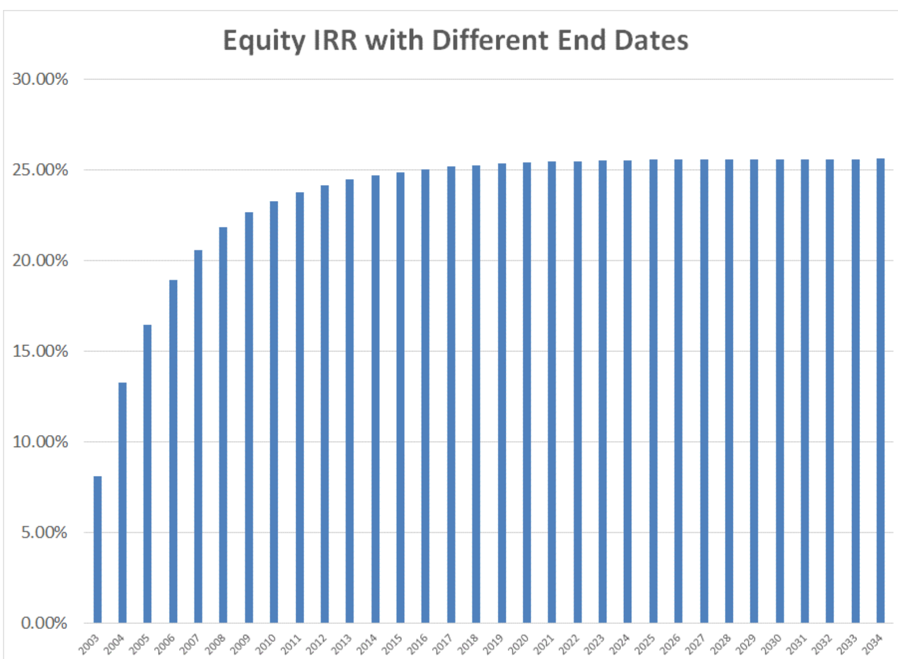


Figure 3.7 – Petrozuata Equity IRR for Different Time Periods

After the project begins operation, the risk changes a lot, just like the risk of a relationship failure changes after the wedding date. The remaining risk other

than political risk for Petrozuata was the oil price. In theory the oil price could be hedged with a forward contract reducing the risk to virtually a risk free project. The project could then be sold to another company and where the buying company should not have a return much higher than the risk free rate. Using futures markets together with low discount rates is discussed in the arbitrage pricing chapter in Part 2. Even if the risk free rate is not used by a prospective buyer, the required return should be a lot lower after the construction period. Assuming the project would be sold where the new buyer would accept a series of lower returns as the risk is resolved produces a maximum IRR of 60% rather than the 25.6% mentioned at the beginning of the section. Figure 3.8 shows different IRR's that result from different sale dates and buyer discount rates. Reasons for the IRR's being different with different sale dates is explained in Part 3. The point of Figure 3.8 is to demonstrate that when it comes to IRR's you can take your pick. Figure 3.8 also confirms that when the IRR is very high, the number in ambiguous as the variation in IRR's is greater.

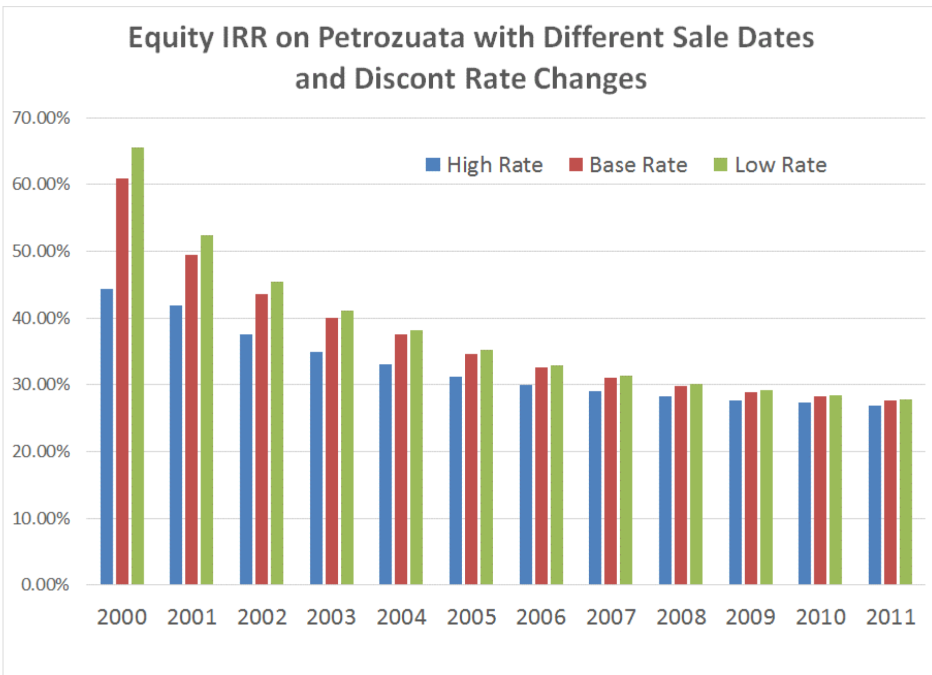


Figure 3.8 – Petrozuata Equity IRR Accounting for Changing Risk in Different Scenarios

To see what an IRR of 25% means, you can compare the amount of money that you make from the 25% IRR with the return you would make by investing at the risk free rate. The additional money you make above the risk free rate is the risk premium. This risk premium you earn can be discounted to the date of the

investment and compared to the size of the investment. You can think of the risk premium measured in this way as follows. Assume that you make the equity investment of $700 million in a risk free investment (the amount of the investment including accumulated interest). Then, you think about either the amount of money you make from the risk free investment or alternatively an investment in Petrozuata. With the Petrozuata investment, you will get the risk free investment as long as things work out, but you ask to be paid for taking the added risk. For Petrozuata, relative to the equity investment of about $700 million made by Conoco, this risk premium you earn for taking risk is $2.6 billion or 172% more than the initial investment. Unlike the IRR, when the risk premium is measured in this way, cash flows at the end of the project make a big difference. The earned risk premium in absolute terms and relative to the equity investment is shown in Figure 3.9. Technical details of computing the risk premium are described in Chapter __ of Part 3 and a video describing the process is explained on the website www.edbodmer.com.

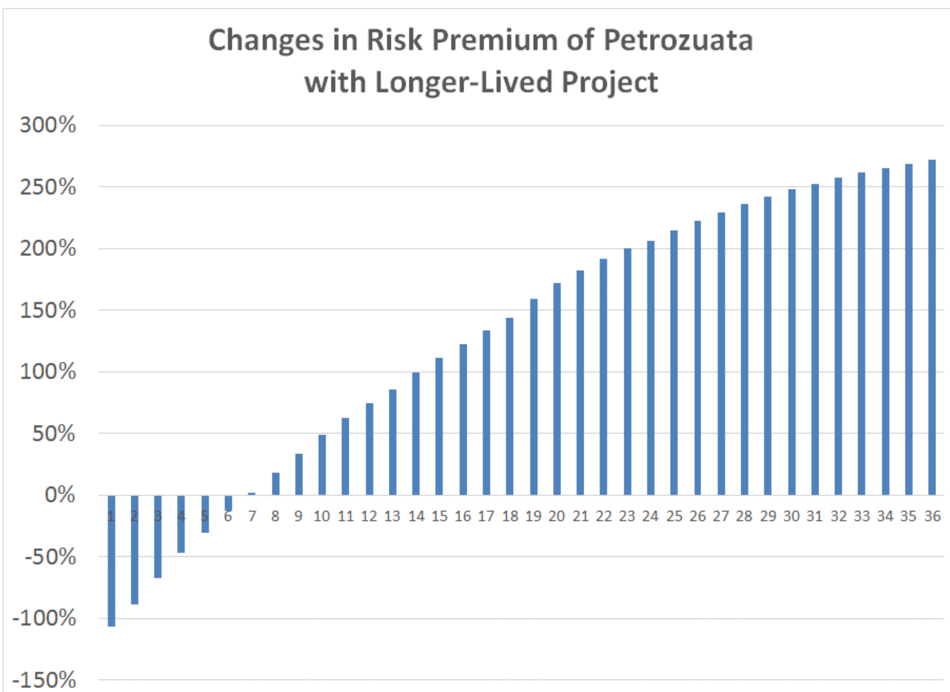


Figure 3.9 – Petrozuata Equity Risk Premium Earned as Percentage of Investment for Different Horizons

Figure 3.9 demonstrates that even though an IRR of 25% earned over 35 years may not sound like it is that high, it is in fact enormous. Downside risks of the project other than the political risk were not very high, particularly given the nominal oil price assumption of a little more than $18.6 per barrel over extending to the year 2035. You can think of the risk premium shown in Figure 3.9 like the

additional salary you would need if you accepted a lower fixed salary plus a variable bonus for an exciting job as compared to a purely fixed salary for a boring job. If there is very little chance that your salary will be less than the fixed amount, you would presumably not need that much more to accept the variability that comes along with the alternative bonus structure. Applying this analogy to Petrozuata with the low oil price assumption would mean that your salary with the variable structure would be many multiples of your base salary. If your base salary was 100,000 for the boring job, the salary for accepting the job with risk that the oil price will be below $18 per barrel in nominal terms will be 372,000. The real question if your bonus is extremely high is whether you are too greedy and whether this high salary can be sustained. This analogous to accepting political risk that the high returns can be continued in the Petrozuata case. The valuation lesson is that the IRR is not a reasonable measure of economic profit when the IRR numbers are big. As an investor, you can ask for this type of high IRR, but it is very difficult to earn this kind of money over a long period without taking very big risks.

Valuation Flaw 3: Expecting to Earn High Returns on Off-Shore Investments and Taking Political Risk

Estimated cost of equity for the project is discussed on the second to last page of the HBS case write-up. The total cost of equity is computed from an un-levered and re-levered beta of refineries, a premium for start-up companies of 2.1%, an equity risk premium of 7% and a country risk premium of 6.67%. Adding these numbers to a risk free rate of 5.6% yields a minimum required return on equity of a whopping 20.95%. -- 5.6% + .94 x 7% + 2.1% + 6.67%. In considering various different issues in the Petrozuata case, most people probably do not pay much attention this 21% number. Similarly, when working with real transactions and seeing discussion of ungeared beta, the equity risk premium, country risk premiums and a start-up premium, managers generally gloss over the numbers and ask about the projected IRR. But the Teaching Guide discusses the cost of capital at length including what sample of companies to use in estimating beta and even adjusting the beta through dividing the volatility of the Venezuelan market by the volatility of the U.S. market. The entire subject of Part 2 involves addressing flaws in attempting to measure the true minimum return investors need to make an investment and demonstrates how irrelevant the whole CAPM process is, before making an irrelevant adjustments for relative volatility. Theoretical problems with computing beta, estimating the equity market premium, making

arbitrary additions for things like start-up companies and distortions from un-levering and re-levering betas are all addressed in Part 2.

The idea that an equity cost of capital of 21% could be appropriate demonstrates nothing other than, when it comes to cost of capital, you can use the CAPM to come up with any number that you want. Without going into details of things like the equity market risk premium, the absurdity of such a high number can be demonstrated from a macroeconomic perspective. If typical investors really need to earn a return 21% before they will make an investment (the implication of a beta close to 1.0 in Venezuela) then it follows that corporate profits will also need to grow by 21% to promote new investments. This means that unless the whole economy grows by 21% or more, somebody in the economy other than investors would have to accept lower income to maintain new investment with the required return. To demonstrate this, pretend the economy only consists of workers and investors, and the economy grows on a nominal basis by 8%. If investors take 21% of the growth out of the economy through profits, it can only mean that other segments must be growing at a rate of less than 8%. The income dispersion would get a worse and worse in this scenario.

The flaw in valuation with respect to using high cost of capital estimates has particularly serious repercussions when a high country risk premium is applied. In the case of Petrozuata the 6.67% premium is used to compensate for potential country risk associated with nationalization would aggravate the political risk and create a self-fulfilling prophecy as illustrated in Figure 3.10. If the political risk premium is high, this means investors will insist on taking a big piece of the difference between the resource value and the production cost as discussed earlier. But people who live in the country will soon figure out how much money is flowing out of the country and they will make all sorts of accusations about corruption and injustice. These accusations increase political risk. A viscous circle is created whereby the country risk premium itself increases political risk which in turn prompts and even higher risk premium and then results in even more dissatisfaction with the foreign investor. A diagram of this process is shown on Figure 3.10.

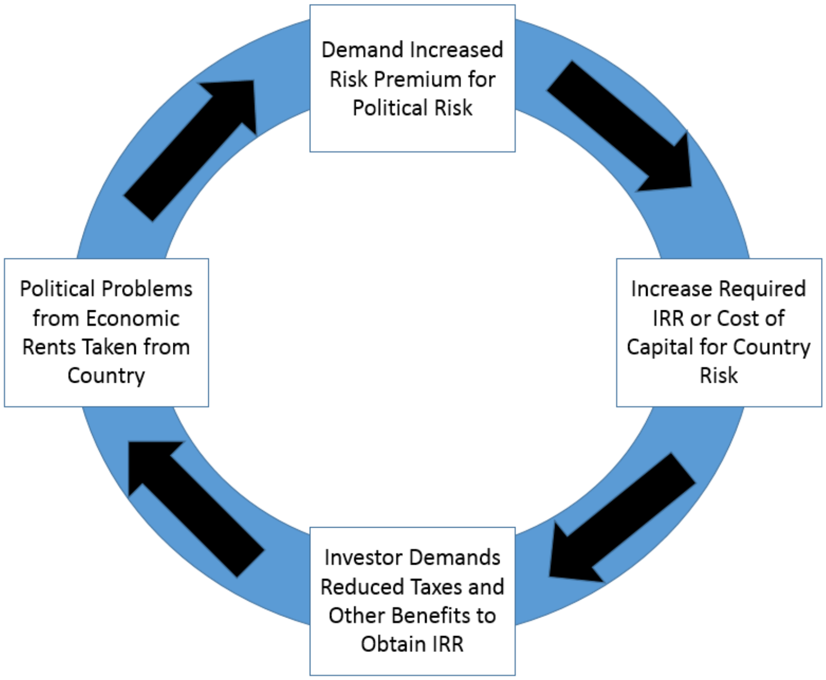


Figure 3.10 – Viscous Circle of Political Risk

Problems in demanding an IRR that includes a high country risk premium can be demonstrated with a hypothetical cash flow analysis using the 6.67% risk premium used in the Petrozuata case write-up. To demonstrate just how high this number is, you can begin by computing the required cash flow to generate an IRR without the risk premium, say 13%. This can be established with a simple goal seek function. Next, the assumed the same investment, but compute the increased cash flow required to generate the higher IRR that includes risk premium.

These higher cash flows can then be reduced by the probability of expropriation and the loss once and expropriation has occurred (like the probability of loss on and investment and the loss given default). The cash flow after probability of expropriation for the country can be derived through multiplying the higher cash flow that is sufficient to produce an IRR with a risk premium by the probability of expropriation less the recovery assumption. Finally, the implied probability of loss can be established through backing into the probability of default that yields the same IRR as the amount that would be adequate without the political risk. Technical details of implied calculation of risk premium are described in Chapter __ or Part 3. Figure 3.11 demonstrates results of the implied probability of expropriation analysis with different assumed expropriation dates and different assumed recovery percentages. The extremely high probabilities show that slapping on high risk premiums on the required rate of return produces nonsensical results.

Probability of Expropriation Table

		Loss, Given Expropriation				
		20%	**40%**	**60%**	**80%**	**100%**
	1	91%	78%	65%	52%	39%
Year of	**3**	102%	89%	75%	62%	49%
Expropriation	**5**	115%	102%	89%	75%	62%
	7	132%	119%	105%	92%	78%
	9	154%	140%	127%	113%	99%

Figure 3.11 – Implied Probability of Expropriation with Different Recovery Rates and Expropriation Timing

The issue of risk premiums for political risk can be evaluated in the Petrozuata case. As shown in Figure 3.2, the project was nationalized after only a few years of operation. In the intervening period, royalty rates and income tax rates on the project increased dramatically. The royalty rate increased from 1% to 30% and the income tax rate increased from 35% to 67%. This can be called creeping nationalization. But over the same period, the oil price was much higher than the amount forecast. Even with the increased taxes, the IRR was higher than forecast because of the oil prices. When looking at Figure 3.4, the IRR increases rapidly and after only a few years obtains a level of 20%. This means that Conoco probably did receive a hither IRR than could have been earned on other projects even though it was nationalized. Finally, Conoco will receive some compensation for its investment as a result of the arbitration proceedings. Venezuela's initial offer was to pay back the book value of Conoco's investment while Conoco is asking for $30 billion. After Conoco receives something in between it will have performed a lot better than investments that would have been made in countries that do not have political risk.

Valuation Issue 4: Upside Potential, Downside Risk and Inappropriate Use of Monte Carlo

The Teaching Guide for the Petrozuata case included a Monte Carlo analysis of the project with respect to the oil price. It suggested using Crystal Ball and applying a 20% volatility statistic to the percent change in the oil price. Using the Monte Carlo simulation a fancy analysis established a very high probability of default of about 30%. The appendix to the teaching note presented a graph like that shown in Figure 3.10 with different oil price projections and also a distribution analysis replicated in Figure 3.11 which can be used to derive the

default probability. Most of the projections shown on the graph in Figure 3.10 resulted in nominal prices below $10 per barrel in 2035. Outputs presented in the simulation analysis include quasi market value and the debt service coverage ratio ("DSCR"). This seemingly sophisticated analysis developed a probability distribution for the DSCR from which a probability of below 1.0 is equated to the probability of default. Figure 3.11 which uses the PLCR instead of the DSCR shows that if the Monte Carlo approach suggested by the Teaching Guide is used, there is an unacceptable probability of loss from the oil price of 24%. All of this analysis that is apparently taught to business school students is utterly meaningless. It is highly doubtful that any of the actual analysis of debt and/or equity value of the actual transaction relied in any way at all on Monte Carlo, particularly the kind on analysis presented in the teaching note. Apparently, business school students are taught how to make things that are relatively simple look sophisticated and confusing.

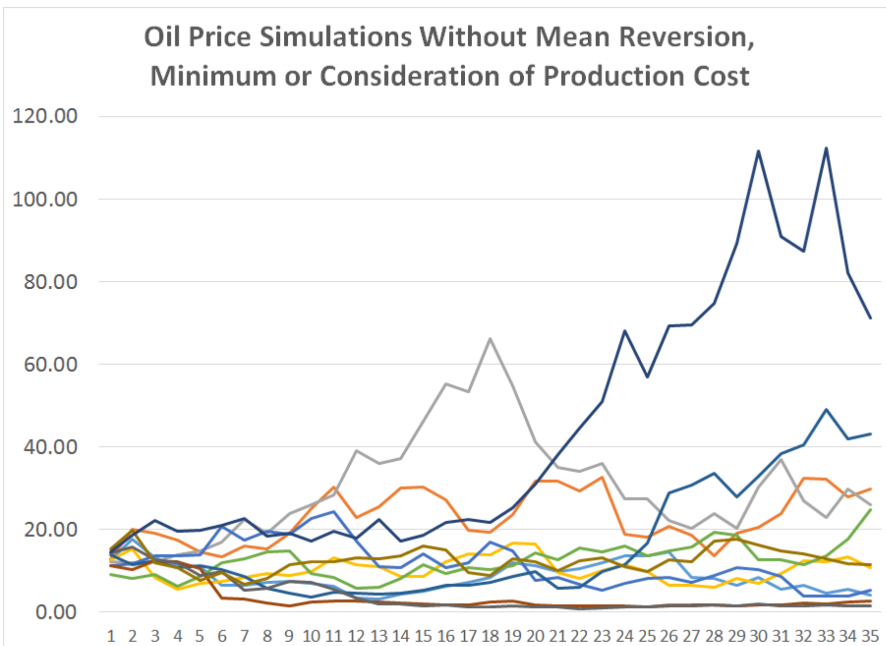


Figure 3.12 – Monte Carlo Simulation without Mean Reversion to Production Cost and Without Minimum Boundary

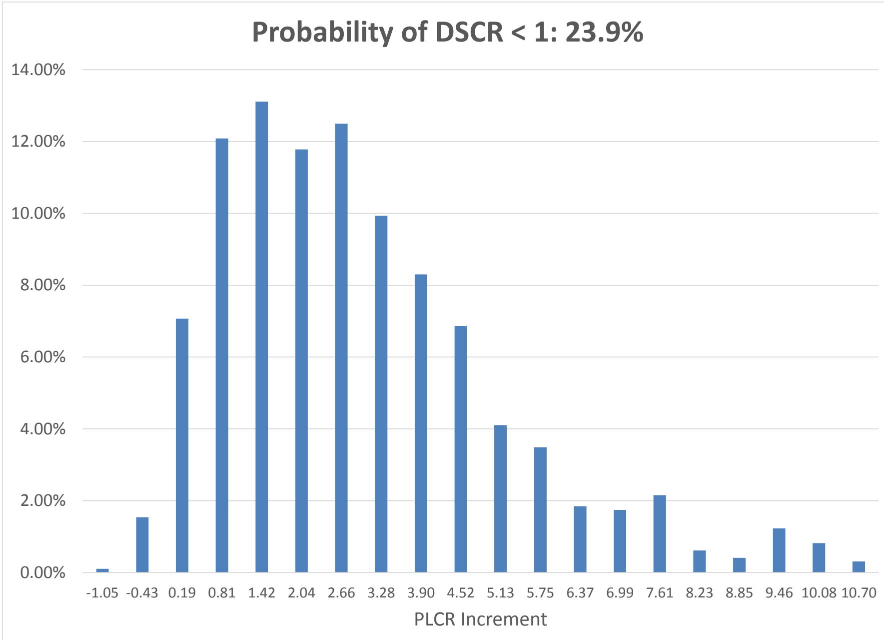


Figure 3.13 – Probability Distribution of PLCR from Monte Carlo Simulation without Mean Reversion to Production Cost and Without Minimum Boundary

The only useful thing to discuss with respect to the Teaching Guide is how this Monte Carlo analysis that produces such sophisticated looking analysis does not produce any useful results unless the underlying production costs are carefully evaluated in creating time series. The Monte Carlo analysis suggested by the HBS teaching guide does demonstrates the danger of becoming impressed with seemingly sophisticated analysis (that is really quite basic). It also demonstrates that unless the analysis carefully evaluates long-run production cost, it does not provide any real answers in terms of value or risk. Some of the issues about how just faulty Monte Carlo analysis is include: (1) demonstrating that probability of default and loss given default can be measured more easily and objectively by break-even analysis than by simulation; (2) showing that you do not need to add any costly add-in into your computer to perform a simulation -- Monte Carlo analysis can be created with a very simple macro; and, (3) confirming that if the production cost and mean reversion is not included in a time series analysis, the Monte Carlo produces a series of irrelevant random numbers.

In evaluating the probability of default, instead of using Monte Carlo simulation, you can simply perform a break-even analysis and then evaluate how low the oil price can go until the loan cannot be repaid. With this type of break-even analysis you could then make some kind of judgment as to the probability associated with the price falling below the break-even level. This would be an approximate assessment of the probability of default. One of the problems with the manner in which analysis from the Teaching Guide applied the probability of default was by only evaluating the DSCR. If the DSCR falls below 1.0 times in

one single year, this is certainly bad news. Cash flow is not sufficient to pay off the debt for that year and if there is no reserve account and/or provision to defer principal payments, a money default will occur. But this default has very little to do with the ability to ultimately pay off the loan. Figure 3.3 demonstrated that there was a whole lot of space between the cash flow and the debt service at end of the project (this graph tells you a lot more about the project than a beautiful frequency distribution graph). The ability to repay the loan over its life can be better measured by a ratio called the project life coverage ratio ("PLCR") which measures the value of the cash flow discounted at the debt rate divided by the size of the loan.

PLCR = NPV(Loan Rate, Cash Flow)/NPV(Loan Rate, Cash Flow), or

PLCR = NPV(Loan Rate, Cash Flow)/Loan Amount

When the DSCR has a value of 1.5, the cash flow can decrease by .5/1.50 or 33%. If the PLCR for the same project is 1.8, the cash flow over the life of the project can fall by .8/1.8 or 44%. For a PLCR of 2.0, the percent decrease in cash flow before the loan defaults is ½ or 50%. The loan life coverage ratio ("LLCR") is similar to the PLCR except the cash flow is truncated over the life of the loan. Figure 3.3 shows that break-even oil price using the DSCR is $8.94 per barrel. This is computed by finding the oil price in the period with the lowest DSCR which is 2.08. That oil price is reduced by 1.08/2.08 or 52% without including tax effects. Using the PLCR, the oil price can fall to $5.35/barrel in nominal terms. This means the oil price would not only have to be $5.35/barrel for one year, it would have to be at that level over the life of the project. Suggesting that there is a positive probability of the nominal oil price being $5.35 per barrel is not plausible. This is far below the short-term marginal cost in most places of the world and nowhere close to the long-term marginal cost required to promote new investment. The implication of the teaching note that the probability of default is somewhere around 30% is unreasonable. The transaction can be much more easily understood by computing a couple or ratios than by creating fancy looking simulations.

Apparently, students at business school are encouraged to create Monte Carlo analysis and then bring these seemingly innovative ideas to real transactions. It all looks elegant and sophisticated with frequency graphs, thousands of simulations, time series equations and cumulative probability calculations. The Teaching Guide suggests that you need to go out and buy an add in program for your excel to do this. Techniques to construct Monte Carlo are described in Part 5 demonstrate that the mechanical process is in fact quite simple. Discussion in this final part of the book demonstrates that creating a simulation once you have a financial model and once you understand the underlying production costs does not require any additional software other than a basic excel sheet. All you need is to write a macro with a couple lines of code. An accompanying video demonstrate

that the results produced in the Teaching Note can be replicated in about ½ an hour.

If Monte Carlo simulation is to be applied to the Petrozuata case, it can be used to demonstrate the importance of incorporating production costs and mean reversion into the process. When analyzing the production cost of oil, the low oil prices in the 1990's were probably reasonably close to short-term production costs. With hindsight we know there was a lot more upside price potential than downside risk from the perspective of oil production. Figure 3.12 demonstrates estimated production costs estimated by the IEA in 2010.[7] Use of this type of supply curve is explained in detail in Part 4 of the book. By inspecting the graph in Figure 3.14 and incorporating the level of demand, the production cost of oil on the margin is somewhere between \$50/barrel and \$80/barrel. Assumption that the price could remain below at \$18/barrel in nominal terms in a base case and that the price could fall below \$5 per barrel for long periods of time is not consistent with any reasonable analysis of long-term production costs. For these low oil price scenarios to occur, demand in the world would have to be so low that no new wells would be drilled and the only production that would occur would be from low marginal cost wells in places like the Middle East.

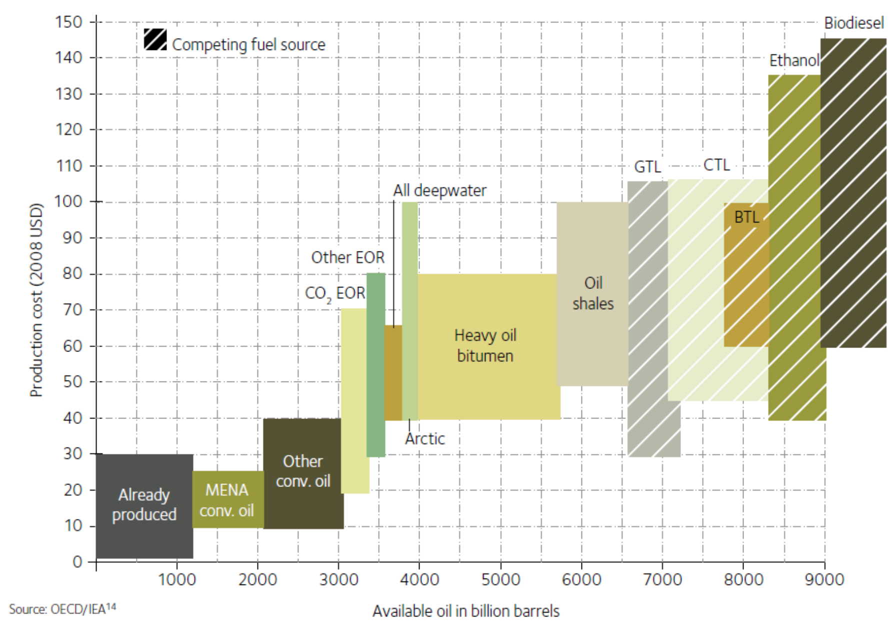
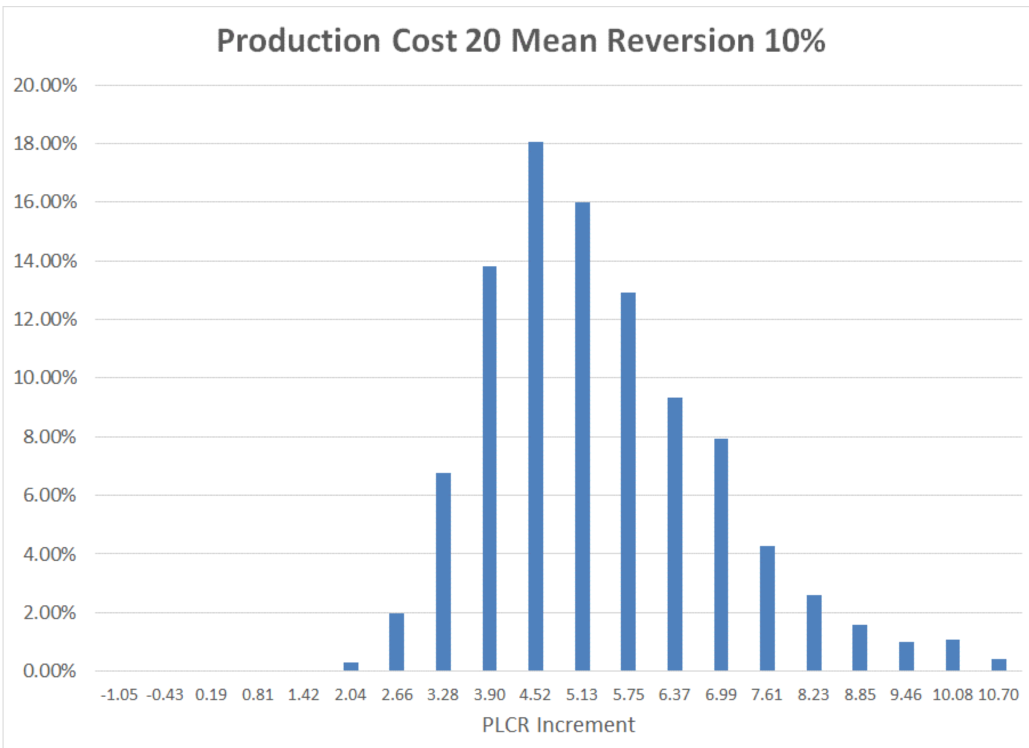


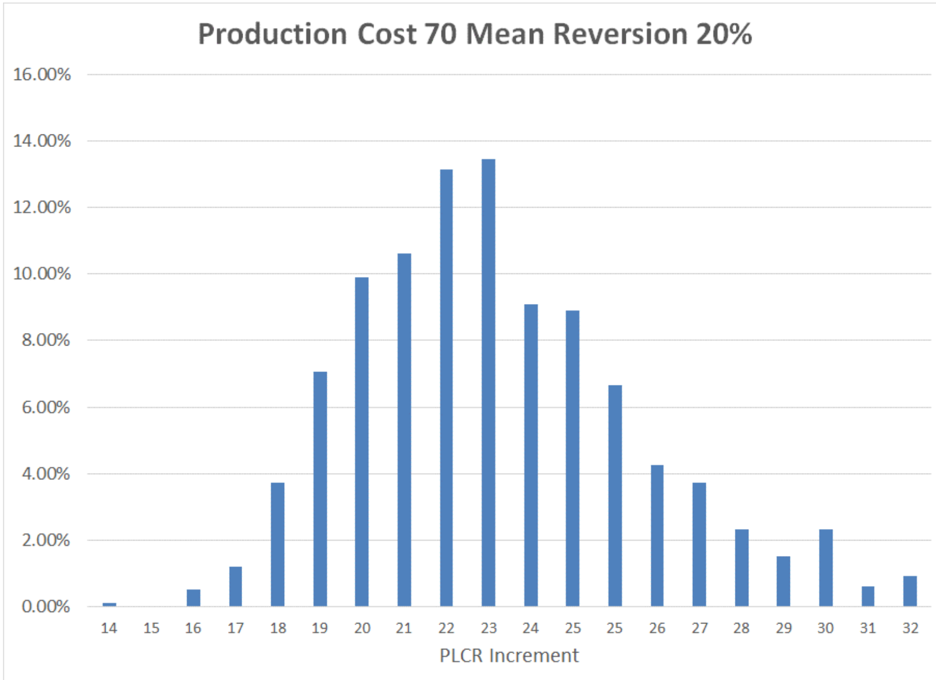
Figure 3.14 – Estimated Production Cost Curve for Oil in 2010

To demonstrate the importance of mean reversion and mean reversion in the Monte Carlo process, the process from the Teaching Guide is compared to use

[7] 14 IEA Flyer for Resources to Reserves 2010, www.iea.org/papers/2010/Flyer_RtoR2010.pdf

of mean reversion to production costs with alternative estimates of production costs. If a very low production cost of $20 per barrel is assumed along with a very low mean reversion rate of 10%, the probability of loss falls to zero. This is demonstrated with the distribution graph in Figure 3.15. With a higher production cost of $50/barrel and a mean reversion of .2, the aggregate debt service coverage ranges between 16 and 32 times as shown in Figure 3.16, nowhere near a value of 1.0 that would imply a default. Technical details for making the calculations are discussed in Part 5 and in an accompanying video. Once the Monte Carlo is corrected for the long-run production costs, mean reversion and short-term marginal costs, the probability of loss is just about zero.




Production Cost 70 Mean Reversion 20%
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
14 15 16 17 18 19 20 21 22 23 24 25 25 26 27 28 29 30 31 32
PLCR Increment